Comparison of Measured and Indicated Calories among New Life Fitness Integrity Series Upright Cycles With the C Console

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Background

In 2007, the Navy Physical Readiness Program Office (N-135F) authorized the use of stationary cycle test as an alternative to the 1.5-mile run in the Navy Physical Fitness Assessment (PFA). A subject exercises on a stationary cycle for 12 minutes. The number of calories generated during the 12 minutes are recorded and used with body weight to predict a 1.5-mile run time (Hodgdon et al, 2007).

Previous work at the Naval Health Research Center (NHRC) has shown that calorie indicators differ in their accuracy across machine models (Vickers, Griswold & Hodgdon, 2006). However, a comparison of 5 elliptical trainers of the same model (Life Fitness CT 9500HR) showed identical cumulative indicated calories for the same speed and resistance (Parker, Griswold & Vickers, 2006). This finding suggested that machines of the same manufacturer's model were comparable in their responses to exercise. As the previous work had been done using elliptical trainers, comparable data was needed for stationary cycles. To that end, the Exercise and Nutritional Sciences Department (ENS) of San Diego State University (SDSU) was tasked by NHRC to conduct validity trials of 3 new Life Fitness Integrity series upright cycle ergometers. The purpose of the test was to determine the comparability of several new cycle ergometers and to see if they met the Navy performance standard of having a 95% confidence interval for the slope of the regression of measured Kcals vs. cycle – indicated Kcals to include the value of 1.0.

Methods

Life Fitness Corporation (Rosemont, IL) provided 3 new model stationary cycles for testing. The cycles were randomly assigned number 1, 2 and 3.

Subjects

Fifteen participants were recruited from the ENS students (7 men and 8 women). Their physical characteristics are provided in Table 1.

Table 1, Physical Characteristics

	Men (n=7)	Women (n=8)	Total
Age	24.7 (2.9)	25.3 (3.1)	25.1 (3.1)
Stature (in)	71.0 (1.9)	65.1 (1.7)	67.9 (3.4)
Weight (lb)	168.7 (13.3)	128.5 (7.6)	147.2 (22.7)

Procedures

Participants reported to the ENS laboratory on 3 occasions for testing. During their first visit, they were informed about the nature of the study, the procedures and risks involved, and given the opportunity to volunteer. Tests were carried out on a single machine during each visit to the laboratory. During each test, the subject worked on the machine at three different power

settings. The work intensity was increased with each successive work bout. Each bout was approximately 12 minutes in length. A 5-minute break was provided between bouts, during which the participant was allowed to remove the spirometry mask and nose clip. The 3 exercise bouts were chosen to elicit heart rates of approximately 105 bpm, 120 bpm and 135 bpm, respectively. During the work bout, expired gas was collected and analyzed using a Parvo™ True One open-circuit spirometry system to provide measurement of the rate of oxygen consumption ($\dot{V}_{O2}$). The system also calculated the kilocalories expended from the oxygen consumption values using the Weir (1949) formula. The total kilocalories expended during minutes 6 to 12 of the test from open-circuit spirometry were recorded. The metabolic cart was calibrated with a 3 liter syringe and standard gas before each test. It was also externally calibrated by having a subject walk at 3 mph on a treadmill. The caloric cost of walking at this speed has been shown to be approximately 11.5 ml/kg/min. The metabolic cart recorded an oxygen uptake of 11.8 ml/kg/min.

Analysis

The number of kilocalories displayed on the machine at minutes 6 and 12 of the work bout were also recorded, and the difference calculated to provide the 6-minute machine estimate of calories expended during this period. The total expended calories from spirometry (**kcal from metabolic cart)** from minute 6 to minute 12 were used as the criterion against which expended calories indicated on the cycle display (**kcal from cycle**) were compared. The regression of **kcal from metabolic cart** vs. **kcal from cycle** was determined for each cycle separately and then the data from all 3 cycles was analyzed collectively (n = 45). Vassar Stats was used to calculated the regression equation and standard error of estimate for each cycle separately and for all 3 cycles collectedly. In addition the 95% confidence interval of the slope was determined for all 3 cycles combined.

Results

Table 2 provides the coefficients for the regression of **kcal from metabolic cart** vs **kcal from cycle** for each machine and for all 3 machines collectively. Also included are the squared correlation coefficient values, the 95% CI for the slope, and the standard error of estimate (SEE).

Table 3. Regression Coefficients[1] for Measured on Indicated Calories for each Machine					
	Machine	Slope (kcal·kcal^{-1})	Intercept (kcal)	r^2	SEE
Cycle	#1	1.056 (0.988, 1.124)	--6.02	0.958	2.62
	#2	1.007 (0.939, 1.074)	-4.49	0.954	2.78
	#3	1.033 (0.977, 1.088)	-5.59	0.971	2.26
	All 3	1.030 (0.994, 1.066)	-5.23	0.960	2.54
[1]Values shown are coefficients and (95% confidence limits)					

Figures 1 – 4 show the individual relationships between indicated and measured calories for each of the machines used in this study and for the collective data for a 3 cycles combined. The dotted lines indicate the least squares linear regression of measured vs. indicated calories. The solid line represents the line of identity. As noted above the indicated calorie values are greater than the measured values for all the machines – however the y-intercept was essentially identical for all 3 instruments (i.e 4-6 kcals).

Conclusion

The main conclusion from this study is that all 3 cycles had slopes that were equal to 1.0 (i.e. the 95% CI for the relationship included 1.0.). This means that they all meet the criteria for validation to be able to be used for the Navy PFA. Having a slope of 1.0 means that the regression line and the line of identity are parallel to each other. The practical application of this finding is that the Kcal correction (i.e., y-intercept offset) can be universally applied to high fit, medium fit, and low fit individuals irrespective of the total Kcals achieved during their PFT when using the Life Fitness Integrity cycle. More importantly, when the data for all 3 cycles was combined, the slope was equal to 1.0 and the y-intercept was -5.23 Kcals. Thus this offset can be readily applied to PFT tests using the Life Fitness Integrity series Upright Cycle Ergometer with the C Console. Lastly, the y-intercept was essentially identical for all 3 cycles tested. This suggests that the y intercept offset can be applied to all models of this cycle.

References

Vickers RR Jr., Griswold L, and Hodgdon JA (2006). A comparison of three models of elliptical trainer. Naval Health Research Center Technical Report No. 06-31, San Diego, CA.

Hodgdon JA, Hervig L, Griswold L, Terry J, Le C, Sausen K, Miller P (2007). 12-minute stationary cycle performance as a predictor of 1.5-mile run time. Naval Health Research Center Technical Report No. 07-41, San Diego, CA.

Parker S, Griswold L, and Vickers R. (2006) Development of an Elliptical training PFT. NHRC TR # 06-06. San Diego , CA 92152

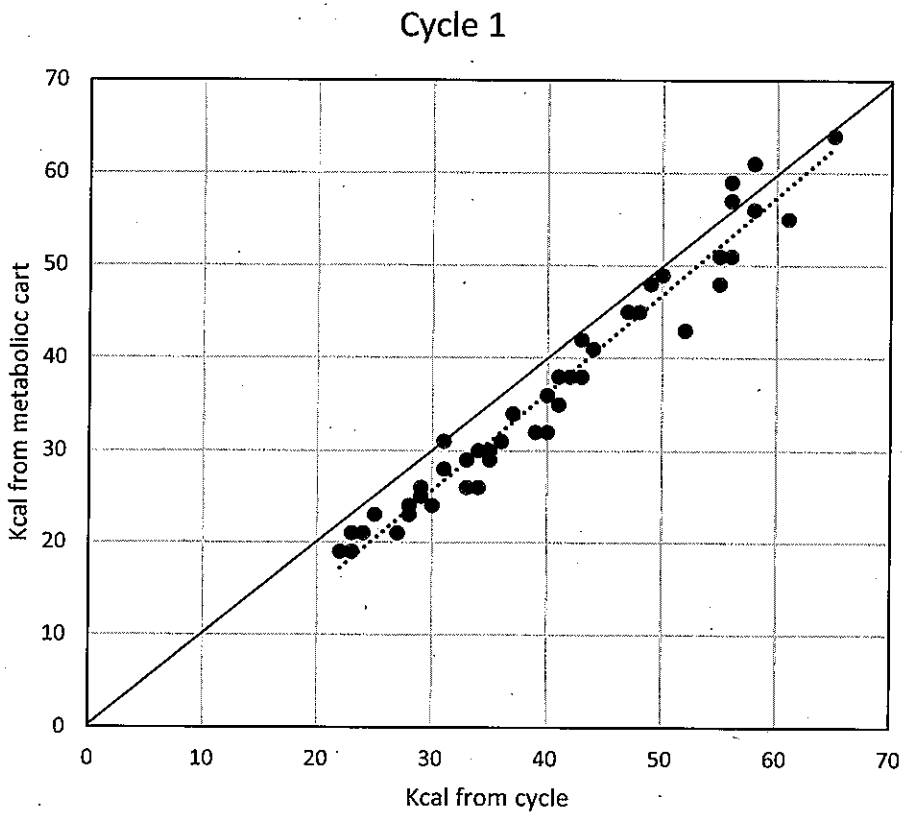
Cycle 1
Kcal from metaboliоc cart
Kcal from cycle
0
10
20
30
40
50
60
70

Figure 1

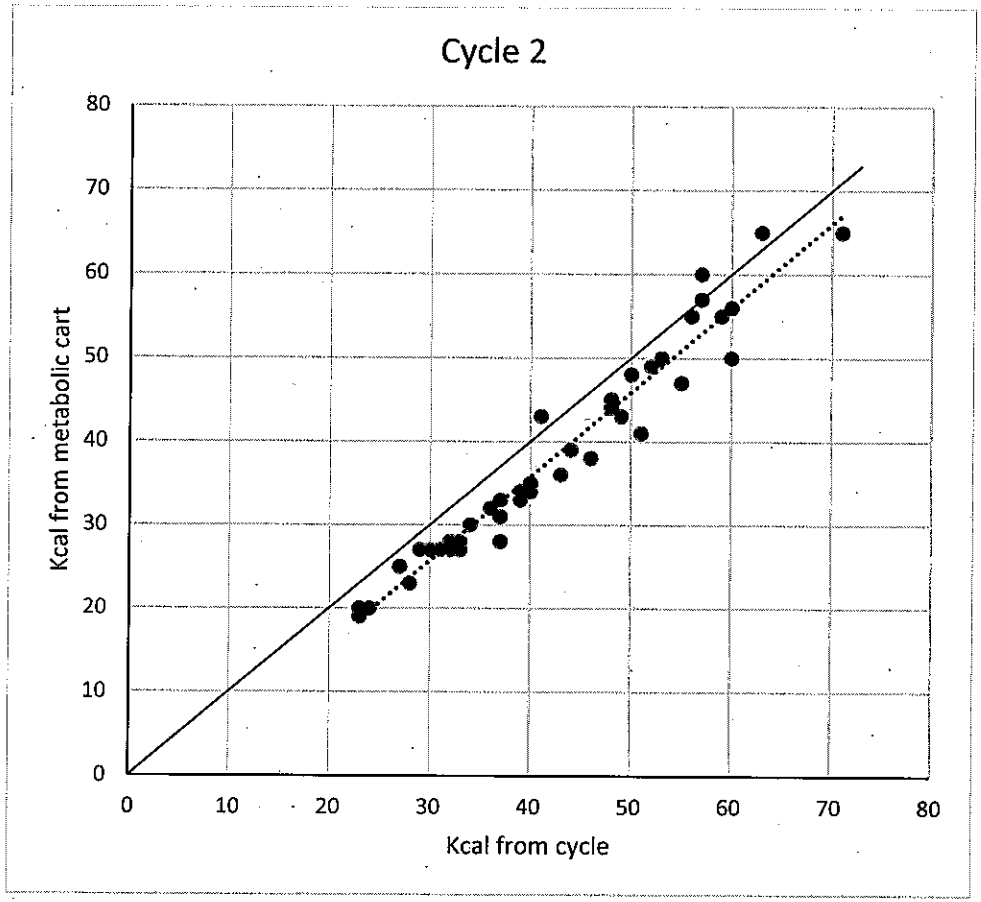
Cycle 2
Kcal from metabolic cart
Kcal from cycle
0
10
20
30
40
50
60
70
80

Figure 2

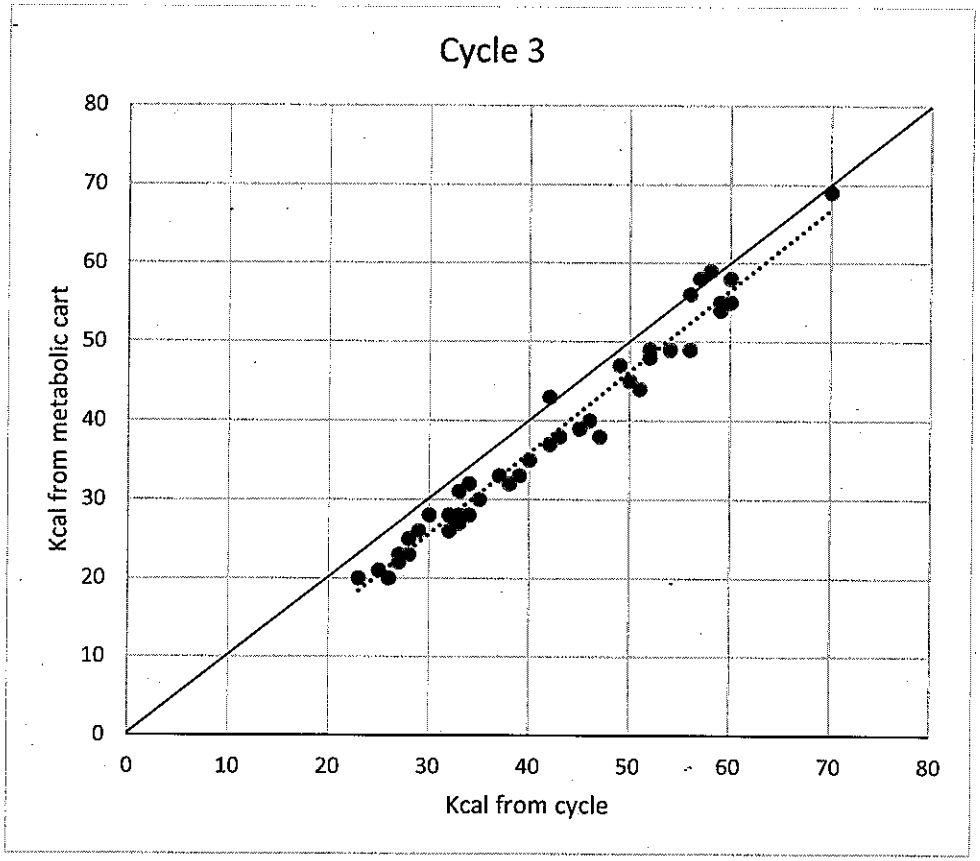
Cycle 3
Kcal from metabolic cart
Kcal from cycle
0
10
20
30
40
50
60
70
80

Figure 3

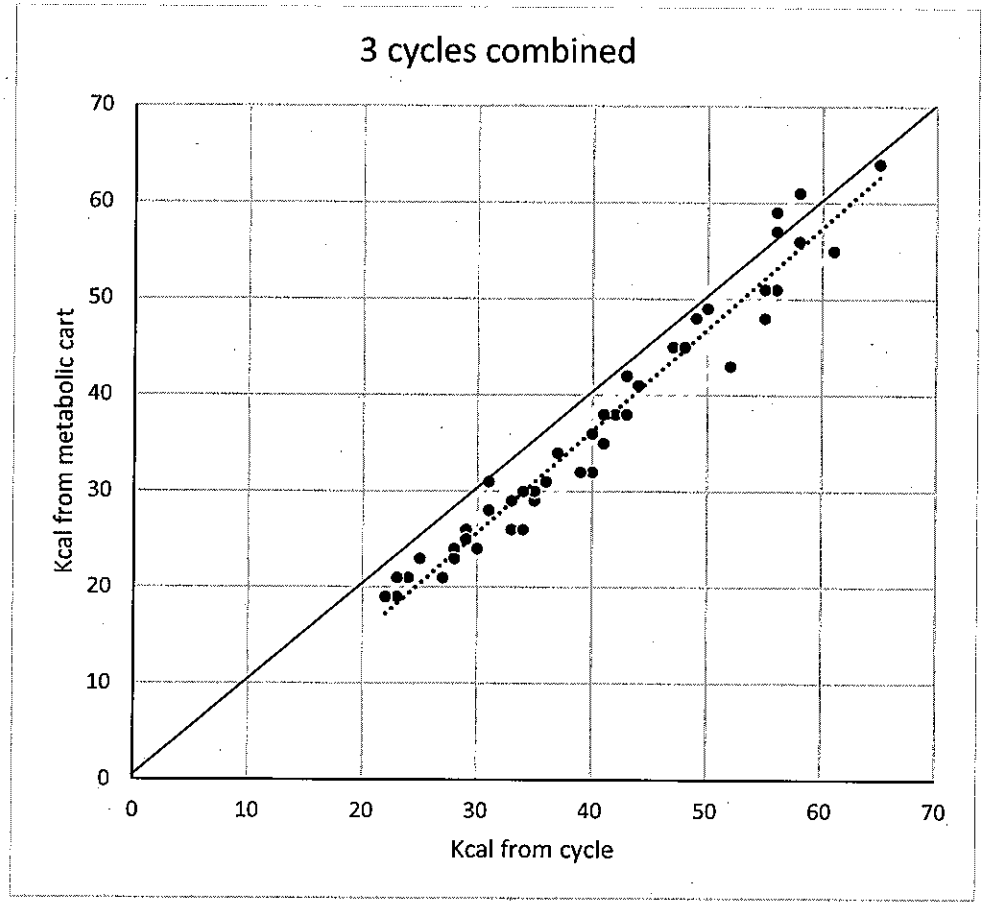
3 cycles combined
Kcal from metabolic cart
Kcal from cycle
0
10
20
30
40
50
60
70

Figure 4